

Claims

1. An organic electroluminescent device comprising:
at least two or more emitting layers between an
5 anode and a cathode, and
an intermediate electrode layer being interposed
between emitting layers,
the intermediate electrode layer being a single
layer or a multilayer structure of a plurality of layers,
10 at least one of the layers comprising a semiconductive
material having a resistivity of 0.001 to 10,000 $\Omega \cdot \text{cm}$.
2. The organic electroluminescent device according to
claim 1, wherein the semiconductive material is a
15 chalcogenide.
3. The organic electroluminescent device according to
claim 1, wherein the semiconductive material comprises a
chalcogenide and an alkali metal.
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4. The organic electroluminescent device according to
claim 1, wherein the semiconductive material is a
conductive oxide.
- 25 5. The organic electroluminescent device according to
claim 4, wherein the conductive oxide contains a
transition metal.
6. The organic electroluminescent device according to
30 claim 5, wherein the conductive oxide containing a

transition metal is at least one oxide selected from the group of NbO_x , LaO_x , NdO_x , SmO_x , EuO_x , MoO_x , ReO_x , WO_x , OsO_x , IrO_x and PtO_x wherein x is 0.2 to 5.

5 7. The organic electroluminescent device according to claim 1, wherein the semiconductive material comprises an acceptor that is a conductive oxide containing a transition metal, and a donor that is an alkali metal and/or an alkaline earth metal.

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8. The organic electroluminescent device according to claim 7, wherein the acceptor is at least one oxide selected from the group of $\text{Li}_x\text{Ti}_2\text{O}_4$, $\text{Li}_x\text{V}_2\text{O}_4$, Er_xNbO_3 , La_xTiO_3 , Sr_xVO_3 , Ca_xCrO_3 , Sr_xCrO_3 , A_xMoO_3 and AV_2O_5 wherein A is K, Cs, Rb, Sr, Na, Li or Ca, and x is 0.2 to 5.

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9. The organic electroluminescent device according to claim 1, wherein the semiconductive material is a conductive organic radical salt represented by the following formula (1):

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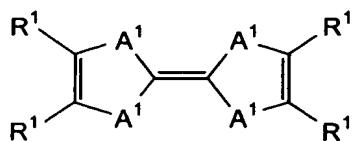
wherein D represents a molecule or an atom having a donor nature, A represents a molecule or an atom having an acceptor nature, y represents an integer of 1 to 5, and z represents an integer of 1 to 5.

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10. The organic electroluminescent device according to claim 9, wherein D is a molecule represented by the

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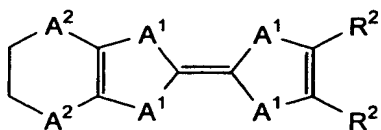
following formulas (2) to (9):



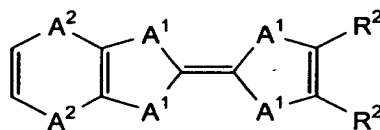
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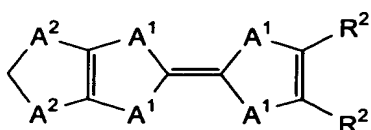
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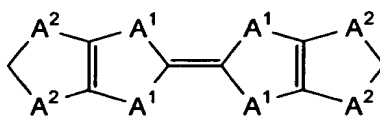
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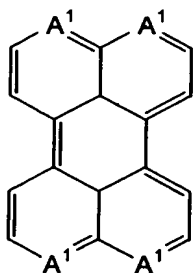
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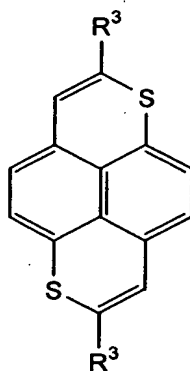
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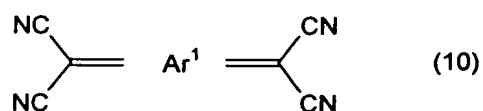
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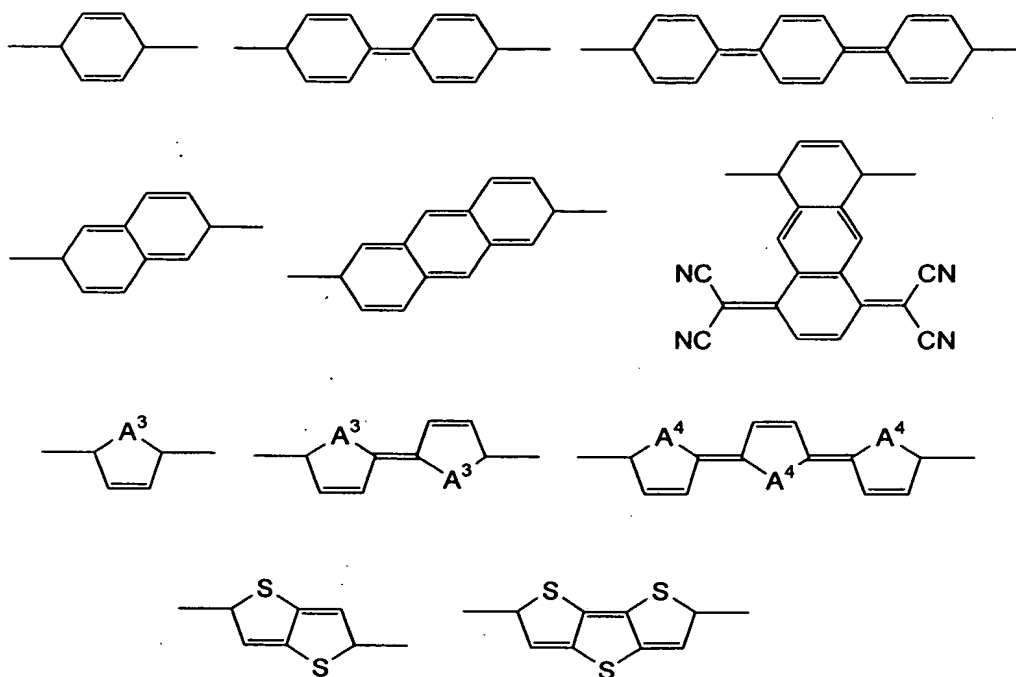
(9)

wherein A¹s independently represent a carbon atom, a sulfur atom, a selenium atom or a tellurium atom, A²s independently represent a carbon atom, a sulfur atom, a selenium atom, a tellurium atom or an oxygen atom, R¹s independently represent a hydrogen atom or a C₁ to 50 alkyl group, R²s independently represent a C₁ to 50 alkyl group or a C₁ to 50 thioalkyl group, and R³s independently represent a hydrogen atom, a C₁ to 50 thioalkyl group or a C₁ to 50 selenoalkyl group.

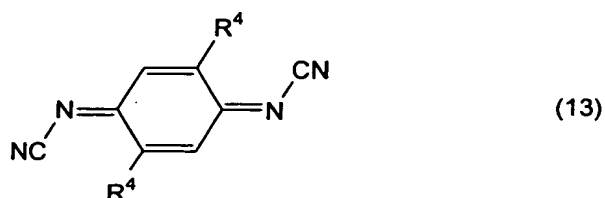
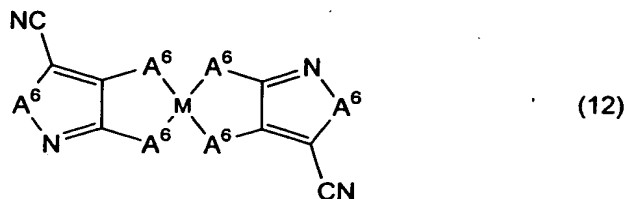
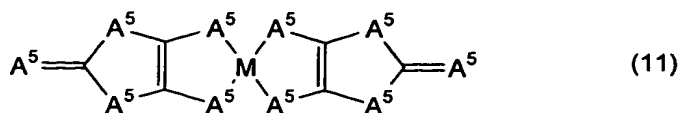
11. The organic electroluminescent device according to claim 9, wherein A is a molecule represented by the following formulas (10) to (13):



5 wherein Ar¹ represents the following organic groups that may be substituted with halogen,



wherein A³s independently represent an oxygen atom, a sulfur atom or a selenium atom, and A⁴s independently represent a sulfur atom or a selenium atom,



wherein A⁵s independently represent a carbon atom, a sulfur atom, a selenium atom, a tellurium atom or an oxygen atom, A⁶s independently represent a carbon atom, a sulfur atom, a selenium atom or a tellurium atom, Ms independently represent a nickel atom, a palladium atom, a platinum atom or a zinc atom, R⁴s independently represent a hydrogen atom, a halogen atom, a C₁ to 50 alkyl group or a C₁ to 50 alkoxy group.

12. The organic electroluminescent device according to claim 11, wherein D is an alkali metal or an alkaline earth metal.

13. An organic electroluminescent device comprising:
 at least one or more emitting layers between an anode and a cathode,
 the cathode comprising at least one metal oxide, and
 the cathode having a light transmittance of 80 % or more.

14. The organic electroluminescent device according to claim 13, further comprising a sealing film made of a transparent material on the cathode, the sealing film
5 having an area larger than the area of an emitting region formed of an overlap between the cathode and the anode.

15. The organic electroluminescent device according to claim 14, wherein the transparent material is an oxide, a
10 nitride or an oxygen nitride of at least one element selected from the group of Si, Ge, Mg, Ta, Ti, Zn, Sn, In, Pb and Bi.

16. The organic electroluminescent device according to claim 14, wherein the transparent material is an oxide, a
15 nitride or an oxygen nitride of at least one element selected from the group of Mo, V, Cr, W, Ni, Co, Mn, Ir, Pt, Pd, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Er and Yb.

20 17. The organic electroluminescent device according to claim 13, wherein the cathode comprises 2 to 20 wt% of a donor.

18. An organic electroluminescent device comprising:
25 one or more emitting layers between an anode and a cathode, and

bipolar charge injection layers being interposed between the anode and at least one of the emitting layers and between the cathode and at least one of the emitting
30 layers.

19. The organic electroluminescent device according to claim 18, wherein the bipolar charge injection layers comprise at least one donor and at least one acceptor.

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20 The organic electroluminescent device according to claim 19, wherein the acceptor is an oxide or a nitride of a transition metal.

10 21. The organic electroluminescent device according to claim 19, wherein the donor is an alkali metal and/or an alkaline earth metal.

15 22. The organic electroluminescent device according to claim 18, wherein the bipolar charge injection layers comprise a mixture of at least one element single substance selected from the group of Cs, Li, Na and K; and at least one oxide selected from the group of MoO_x , VO_x , ReO_x , RuO_x , WO_x , ZnO_x , TiO_x , and CuO_x wherein x is 0.5 to 5.

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23. The organic electroluminescent device according to claim 22, wherein the content of the element is 2 to 20 wt%.

25 24. The organic electroluminescent device according to claim 1, wherein the semiconductive material has a resistivity of not less than $0.001 \Omega \cdot \text{cm}$ but less than $100 \Omega \cdot \text{cm}$.

30 25. An organic electroluminescent device comprising:

at least one or more emitting layers between an anode and a cathode,

the cathode comprising at least one donor and at least one acceptor comprising a metal oxide, and the cathode having a light transmittance of 80 % or more.

26. The organic electroluminescent device according to any one of claims 1 to 12 and 24, wherein the intermediate electrode layer is a bipolar charge injection layer.

27. The organic electroluminescent device according to any one of claims 18 to 23 and 25, wherein the anode or the cathode is the same as the bipolar charge injection layer.

28. A display comprising a screen comprising the organic electroluminescent device according to any one of claims 1 to 25.